

Remarks

Claims 15, 17-20, and 23-27 have been amended. Claims 16, 21, and 22 have been cancelled. Claims 1-14 were cancelled in the Preliminary Amendment. Claims 15, 17-20, and 23-27 are pending in the application and are presented for the Examiner's review and consideration. Applicant submits that the substitute specification, replacement drawing, claim amendments, and the accompanying remarks herein serve to clarify the present invention and are independent of patentability. No new matter has been added.

Amendments to the Drawings

No new matter has been added by the amendment to the figure made herein. Label "7" has been added to indicate the phantom lines 7 as disclosed in paragraph [0012] of the published application U.S. Patent Application Publication 2007/0261570 A1; hereinafter "published application."

Amendments to the Specification

No new matter has been added by the amendments to the specification made herein. The specification has been amended to identify each section by title in accordance with 37 C.F.R. 1.77 and MPEP 608.01(a); to add a reference to the related PCT application; to describe the figure; and to delete references to cancelled claims.

The abstract has been amended to indicate that the invention provides both an apparatus for decontamination of produce and produce decontaminated using the apparatus. *See* paragraphs [0006]-[0008] of the published application.

The adjustable property of lower conveyor 22 is described in paragraph [0012] and shown in the figure. A position to which the lower conveyor belt 26 can be adjusted to is illustrated using phantom lines 7. Paragraph [0012] has been amended to indicate that element 28, as shown in the figure, represents the lower conveyor belt 26 in an adjusted position.

Fenton's Reaction is described in paragraph [0024]. This well-known reaction involves hydrogen peroxide (H_2O_2) and a ferrous iron (Fe^{2+}) catalyst. Ferric iron (Fe^{3+}) is a by-product of

this reaction. Although the iron catalyst (Fe^{2+}) is shown correctly by valance number and formula, it was inadvertently referred to as “ferric” throughout the specification. Thus, the specification has been amended to correct this typographical error. No new matter has been added. One of skill in the art would be very familiar with the difference between “ferrous” and “ferric” iron and would recognize the error immediately. *See* attached definitions of “ferrous” and “ferric” as obtained from the web site dictionary.com.

Amendments to the Claims

No new matter has been added by the amendments to claims 15, 17-20, and 23-27 made herein. These claims have been amended for correction of dependencies with regard to cancelled claims, for consistency of language, and to provide proper antecedent basis for all recited terms.

Specifically, claim 15 has been amended to incorporate the subject matter of cancelled claims 16, 21, and 22. Claim 20 has been amended to clarify that the iron catalyst is ferrous iron. *See* above discussion of ferric and ferrous iron.

Objection to the Drawings

The drawings were objected to under 37 C.F.R. § 1.84(p)(5) as allegedly failing to define all elements shown in the figure. Specifically, the Examiner asserts that element **28**, while shown in the figure, is not mentioned in the specification.

In response, paragraph [0012] has been amended to define element **28** as a view of the lower conveyor belt **26** in an adjusted position. No new matter has been added. Element **28** is described in the specification as originally filed. As noted above, the adjustable property of lower conveyor **22** is described in paragraph [0012] and shown in the figure. A position to which the lower conveyor belt **26** can be adjusted to is illustrated using phantom lines 7.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of this objection to the drawings.

Objection to the Specification

The specification was objected to for informalities. Specifically, the Examiner asserts that the content of specification is not labeled according to the standard guidelines.

In response, the specification has been amended to identify each section by title in accordance with 37 C.F.R. 1.77 and MPEP 608.01(a).

Accordingly, Applicant respectfully requests reconsideration and withdrawal of this objection to the specification.

Rejection under 35 U.S.C. §112

Claims 22 and 23 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite for allegedly failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. Specifically, the phrase “the means for catalyzing the breakdown of the ozone” as recited in claim 22 lacks antecedent basis.

In response, claim 22 has been cancelled and the subject matter incorporated into amended claim 15 with proper antecedent basis.

Accordingly, Applicant has addressed the rejection and respectfully requests reconsideration and withdrawal of this rejection under 35 U.S.C. §112, second paragraph.

Rejection under 35 U.S.C. §102(b)

Claims 15-18, 22, 26, and 27 were rejected under 35 U.S.C. §102(b) as allegedly being anticipated by Eldredge, et al. (International Application No. WO 01/78793 A1; hereinafter “Eldredge”).

For reasons set forth below, Applicant respectfully submits that this rejection should be withdrawn.

Eldredge

Eldredge discloses an apparatus and method for producing a sterilizing agent containing hydrogen peroxide, singlet oxygen, oxygen ions, ozone, and hydroxyls. *See* abstract; page 1, lines 2-6; and page 8, line 24-page 9, line 2. The apparatus and method can be used for sterilization of air, liquids, and/or surfaces. *See* abstract and page 22, lines 18-20. The apparatus for producing the sterilizing agent includes an oxygen concentrator that creates a supply of O₂ from the air; an ozone generator that makes O₃ from the supply of O₂; a moisture control device that regulates the humidity or moisture in the supply of O₂/O₃ mixture; an ultraviolet (UV) light

that generates UV light in the presence of O₃ and moisture; and a contact chamber. Living matter is rendered non-viable through contact with the sterilizing agent in the contact chamber. *See* abstract and page 8, lines 6-16. In the method of sterilization using the apparatus, a sterilant gas is formed by concentration of oxygen, generating ozone from the oxygen, humidifying the mixture of oxygen and ozone, irradiating the humidified mixture of oxygen and ozone with UV light to form a sterilant. *See* abstract and Fig. 1A. The apparatus/method can be used in an agricultural product storage device. *See* 9, lines 11-17; page 28, line 15-page 29, line 19; and Fig. 4.

Instant Invention

The instant invention, as claimed herein in independent claim 15, provides a produce decontamination apparatus having a chamber for accepting produce to be decontaminated and/or sterilised. The apparatus includes means for producing a free radical saturated atmosphere within the chamber so that, in use, the free radical saturated atmosphere decontaminates and/or sterilises the produce, the means for producing a free radical saturated atmosphere including one or more first atomising sprayheads, a supply of ozonised liquid which is supplied to the first sprayheads, means for breaking down a ozone forming part of the ozonised liquid once discharged from the first sprayheads, said means for catalysing breakdown of ozone including a coating on an interior of the chamber, the coating having one or more ozone catalysing materials. The invention also provides methods for decontamination of produce using the apparatus and produce decontaminated by the apparatus. *See* abstract; paragraphs [0006]-[0008]; and paragraph [0023] of the published application.

Argument

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). *See* MPEP 2131.

The Examiner appears to believe that the claimed apparatus is equivalent to the apparatus of Eldredge. Applicant respectfully disagrees.

The teachings of Eldredge are described above.

As noted above, the apparatus, as currently claimed in independent claim 15, includes a coating having one or more ozone catalysing materials on the interior of the chamber. The coating protects against ozone build up inside the chamber. Additionally, coating the interior of the chamber with the catalyst minimizes the space taken up by the catalyst and ensures that the catalyst surrounds the entire chamber.

The Examiner asserts that Eldredge discloses the use of coatings as a means for catalyzing the breakdown of ozone including a coating on the interior surface of the chamber, the coatings having one or more ozone catalyzing materials (page 17, line 22-24-page 18 lines 104).

Applicant respectfully disagrees with the Examiner's interpretation of the disclosure of Eldredge. In the cited portion, Eldredge notes the corrosive and explosive nature of the ozone and thus, the need for non-corrodible parts to be used in the apparatus. Eldredge mentions neither ozone-catalyzing material nor even coating the interior of the apparatus with any kind of material.

To establish a proper rejection under 35 U.S.C. §102 (b), the reference must teach all of the claimed elements of the rejected claims. As established, the cited reference (Eldredge) does not teach each and every element of the invention as currently claimed in independent claim 15.

Accordingly, independent claim 15 is not anticipated by Eldredge. As claims 17, 18, 22, 26, and 27 depend from claim 15, these dependent claims necessarily include all the elements of their base claim. Accordingly, Applicant respectfully submits that the dependent claims are allowable over Eldredge for at least the same reasons.

In light of the foregoing, Applicant respectfully requests reconsideration and withdrawal of this rejection under 35 U.S.C. §102(b).

Rejections under 35 U.S.C. §103(a)

Claims 19, 20, and 21 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Eldredge in view of the "Springer-Link Journal Article" (Eary, *Metallurgical and Materials Transactions B*, 16(2):181-186, 1985; hereinafter "Eary"). Claim 23 was rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Eldredge in view of "CSA Illumina" (Singh et al., Air and Waste Management Association, Pittsburg, PA 15222, 1997; hereinafter "Singh"). Claims 24 and 25 were rejected under 35 U.S.C. §103(a) as allegedly

being unpatentable over Eldredge in view of Kamm et al. (U.S. Patent No. 6,725,674 B1; hereinafter “Kamm”). For reasons set forth below, Applicant respectfully submits that all of these rejections should be withdrawn.

It is noted that the references are described separately to clarify what the reference teaches and not to argue the references individually. The combined teachings of the references are addressed below in the section entitled “Argument.”

The teachings of Eldredge and the instant invention are as applied above.

Eary

Eary describes the decomposition of hydrogen peroxide in acidic solutions (sulfuric acid) catalyzed by free ferric ion (Fe^{3+}). Eary examined the rates of this reaction to optimize solutions used for leaching uranium deposits. *See* abstract and Introduction.

Singh

Singh discusses the toxicity of ozone and the application of a manganese dioxide catalyst to decompose ozone at ambient temperatures. *See* abstract.

Kamm

Kamm discloses a device and method for cryogenic freezing of materials, such as foodstuffs, which requires limited floor space. In use, material is exposed to a cryogenic coolant while being moved up and down through a housing including two towers. *See* abstract and column 1, lines 5-12, 30-40.

Argument

All of the claims (19, 20, 21, and 23-25) rejected herein under 35 U.S.C. §103(a) are dependent upon claim 15. As established above, claim 15 is not anticipated by Eldredge as Eldredge does not teach coating of the interior of the chamber with an ozone-catalyzing material. Thus, in order to establish a proper *prima facie* case of obviousness, the Examiner would first, need a reference that teaches such a coating and second, some reason or motivation to combine this reference(s) with Eldredge. *See* MPEP 2141.

Applicant respectfully submits that the deficiency of Eldredge (lack of disclosure an interior chamber coated with an ozone-catalyzing material) is not remedied by any of the three cited references (Eary, Singh, and Kamm) as none of these references teach a coating of ozone-catalyzing material. Thus, even if one of ordinary skill in the art were to combine the teachings of Eldredge with Eary, Singh, or Kamm one would still not obtain the produce decontamination apparatus as currently claimed.

Furthermore, the cited references (Eary, Singh, and Kamm) are not related to the invention as claimed in a significant manner to provide a meaningful combination with Eldredge.

For example, Eary discloses decomposition of hydrogen peroxide by ferric ion in acidic solutions. This reaction is not akin to the ozonized water and ferrous solution reaction that is carried out by the claimed apparatus. *See* paragraphs [0014]-[0019] of the published application.

Singh discusses the toxicity of ozone and teaches that manganese dioxide-based catalysts provide high ozone destruction efficiencies at ambient temperatures whereas other available technologies require higher temperatures. Singh makes no mention of coating surfaces with the manganese dioxide-based catalysts.

The Examiner relies on Kamm to teach adjustable vertical spacing between conveyor belts and asserts that Kamm discloses two conveyors (4 and 5) in which material is moved up a first tower by a first conveyor (4) and then later moved down a second tower by a second conveyor (5).

Applicant respectfully disagrees with the Examiner's interpretation. Elements **4** and **5** are identified and shown by Kamm as lifting devices. The material is moved through the towers **6** and **7** by lifting and locking into place with locking mechanisms **8** and **9**. *See* column 5, lines 24-48 and Figure 1. This motion is closer to an elevator than to the flow path of the apparatus as currently claimed. Furthermore, Kamm discloses that the device was designed to require only a small floor space and not to allow for produce to be thoroughly affected by the liquid as the Examiner asserts. *See* abstract and column 1, lines 23-27 of Kamm.

Therefore, based on all of the above, it is clear that there is no suggestion or motivation in Eldredge, Eary, Singh, Kamm, or any other prior art to make an apparatus for decontamination of produce as currently claimed.

Accordingly, independent claim 15 is patentable over Eldredge in view of Eary, Sing, or

Kamm. As claims 19, 20, and 23-25 depend from claim 15, these dependent claims necessarily include all the elements of their base claim. Accordingly, Applicant respectfully submits that the dependent claims are allowable over Eldredge in view of Eary, Sing, or Kamm for at least the same reasons.

In light of the foregoing, Applicant respectfully requests reconsideration and withdrawal of these rejections under 35 U.S.C. §103(a).

Conclusion

In light of the foregoing substitute specification, replacement drawing, amendments, and remarks this application is now in condition for allowance and early passage of this case to issue is respectfully requested. If any questions remain regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

The fee for a two-month extension of time pursuant to 1.17(a)(2) in the amount of \$245 is believed to be due and is being paid via credit card. No other fees are believed to be due at this time. However, please charge any other required fees (or credit any overpayments of fees) to the Deposit Account of the undersigned, Account No. 500601 (Docket No. 7043-X06-002).

Respectfully submitted,

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For: PRODUCE DECONTAMINATION
APPARATUS

Examiner: Hemant Mathai Mathew

MARKED-UP SPECIFICATION

PRODUCE DECONTAMINATION APPARATUS

Cross-Reference to Related Application

This application is a U.S. national stage of PCT International Application No. PCT/GB2004/004636, filed on November 4, 2004.

Field of the Invention

This invention relates to produce decontamination apparatus and, more particularly, to the decontamination of produce by free radical washing.

Background of the Invention

Fresh produce is typically washed, post harvest, with various decontaminating solutions containing biocide, such as chlorine / chlorine dioxide, ozone, or any number of combinations of chemicals. This is intended to reduce the risk of introducing potentially damaging or pathogenic microorganisms to the consumer.

However, the use of chemicals within the food chain is now less acceptable, and many chemical biocides are now limited by legislation.

Traditional techniques of sanitisation or decontamination use vast quantities of water, which is also a valuable commodity.

The present invention seeks to provide a solution to these problems.

Brief Summary of the Invention

According to a first aspect of the present invention, there is provided produce decontamination apparatus comprising a chamber for accepting produce to be decontaminated and/or sterilised, and means for producing a free radical saturated atmosphere within the chamber so that, in use, the free radical saturated atmosphere decontaminates and/or sterilises the produce.

Preferable and/or optional features of the invention are set forth in the claims 2 to 12, inclusive.

According to a second aspect of the present invention, there is provided produce decontaminated using produce decontamination apparatus in accordance with the first aspect of the invention.

Brief Description of the Figures

The invention will now be more particularly described, by way of example only, with reference to the only accompanying figure. ~~which shows diagrammatically a cross-sectional elevation of one embodiment of produce decontamination apparatus~~

FIG. 1 shows diagrammatically a cross-sectional elevation view of one embodiment of the produce decontamination apparatus.

Detailed Description of the Invention

Referring to ~~the figure~~ FIG. 1, there is shown produce decontamination apparatus which comprises a substantially enclosed chamber 10 which is open to

atmospheric pressure and which has a produce inlet 12, a produce outlet 14, an air inlet 16, a pumped chamber exhaust 18, and two conveyors 20 and 22.

Each conveyor 20 and 22 includes a conveyor belt 24 and 26 fully housed within the chamber 10. The conveyor belts 24 and 26 are vertically spaced apart and horizontally positioned relative to each other so that one end of the upper conveyor belt 24 overhangs the lower conveyor belt 26. A produce flow path is thus generated horizontally along the upper conveyor belt 24, vertically down from the upper conveyor belt 24 to the lower conveyor belt 26, and then horizontally along the lower conveyor belt 26, as indicated by arrows A.

The vertical spacing between the upper and lower conveyor belts 24 and 26 is adjustable through an adjustment mechanism (not shown). The adjustment mechanism typically allows height adjustment of the lower conveyor belt 26, as shown in the figure by the phantom lines 7 and arrows B. However, the upper conveyor belt 24 could alternatively or additionally be height adjustable. An adjusted position 28 is shown in the figure.

Sprayheads 30 are located within the chamber 10, and form part of means for producing a free radical saturated atmosphere. The sprayheads 30 are provided along the full extent of the produce flow path A. More specifically, the sprayheads 30 are provided at a constant spacing directly above each conveyor belt 24 and 26 and also at the vertical spacing between the upper and lower conveyor belts 24 and 26. Since the

vertical spacing between the upper and lower conveyor belts 24 and 26 is an open space, the sprayheads 30 are provided on at least two sides.

The sprayheads 30 are atomising sprayheads and discharge a non-condensing mist of liquid having a droplet size of between 1 and 15 microns. The average droplet size is preferably 5 microns.

The sprayheads 30 are divided into ozone and ~~ferrie~~ ferrous sprayheads 30a and 30b. The ozone sprayheads 30a are fluidly-connected to a first supply 32 of ozonised liquid, typically being ozonised water; and the ~~ferrie~~ ferrous sprayheads 30b are fluidly-connected to a second supply 34 of liquid, typically water, having ~~ferrie~~ ferrous ions. The first and second supplies 32 and 34 reside externally of the chamber 10.

The first supply 32 includes a reservoir 36 and a pump 38 for supplying the liquid in the reservoir 36 to the ozone sprayheads 30a at the correct pressure to ensure atomisation. The liquid passing from reservoir 36 to the ozone sprayheads 30a is initially pumped through a venturi 40 or any other similar device by which ozone from an ozone generator 42 can be introduced. The ozone concentration is regulated at between 1 and 5 parts-per-million (ppm).

The second supply 34 includes a reservoir 44 and a pump 46. The liquid in the reservoir 44 is charged with ~~ferrie~~ ferrous salts, such as ~~Ferrie~~ ferrous Sulphate, typically in the concentration of 10 to 15 ppm. However, different concentrations depending on necessity can be used.

The ~~ferrie~~ ferrous sprayheads 30b and the second supply 34 together form means for catalysing the breakdown of hydrogen peroxide which is formed by the breakdown of ozone discharged as part of the ozonised liquid from the ozone sprayheads 30a.

The ozone and ~~ferrie~~ ferrous sprayheads 30a and 30b are provided in alternating fashion along the produce flow path A. A ~~ferrie~~ ferrous sprayhead 30b is provided at the beginning of the flow path A.

Means for breaking down the ozone discharged as part of the ozonised liquid from the first sprayheads 30a are in the form of ultraviolet light emitting devices 48, typically being UV fluorescent tubes. The UV light emitting devices 48 are waterproof and are mounted along the full extent of the produce flow path. Specifically, the UV light emitting devices 48 are positioned at a constant spacing directly above the upper and lower conveyor belts 24 and 26, and at the vertical spacing between the two conveyor belts 24 and 26. As with the sprayheads 30, the UV light emitting devices 48 are positioned on at least two sides at the vertical spacing between the two conveyor belts 24 and 26.

Further UV light emitting devices 50 are also provided in any redundant spaces within the chamber 10 to ensure full exposure of the ozonised liquid to the ultraviolet light.

The UV light emitting devices 48,50 emit ultraviolet light at wavelengths of between 185 and 253.7 nanometres.

To catalyse the breakdown of the ozone discharged as part of the ozonised liquid from the ozone sprayheads 30a, the interior surfaces 52 of the chamber 10 have a coating including an ozone catalysing agent or agents. At least one of the ozone catalysing agents is titanium oxide or titanium dioxide. This coating forms ozone catalysing means, and helps to ensure that there is no build up of ozone contamination within the chamber 10.

Ozone in solution breaks down rapidly when subjected to ultraviolet light to form hydrogen peroxide H_2O_2 , which itself then breaks down to form peroxide radicals $HO-OH$, and finally highly reactive hydroxyl radicals OH^\bullet and OH^- . The rate of conversion from hydrogen peroxide to hydroxyl radicals can be greatly enhanced by the use of ~~ferrie~~ ferrous ions Fe^{2+} , which act as a catalyst during their conversion to ferric ~~ferrous~~ ions Fe^{3+} . This is generally known as Fenton's Reaction, and follows the formula :



In use, a dense mist is generated in the interior of the chamber 10 through discharge of atomised ozonised liquid via the ozone sprayheads 30a and atomised liquid having ~~ferrie~~ ferrous ions via the ~~ferrie~~ ferrous sprayheads 30b. The atmosphere within the interior of the chamber 10 thus becomes saturated with free radicals resulting from

the catalysed breakdown of the ozone of the discharged ozonised liquid and the hydrogen peroxide.

To ensure that the free radical saturated atmosphere does not leak out to the general environment in which the apparatus is placed, the pumped chamber exhaust 18 generates a slight negative pressure within the chamber 10 by recirculating a portion of the free radical saturated atmosphere (arrow C) and promoting the ingress of ambient air through air inlet 16 (arrow D).

Produce to be decontaminated or sterilised is introduced into the chamber 10 through produce inlet 12 (arrow E). The produce is first subjected to a spray of the liquid having the ~~ferrie~~ ferrous ions from the ~~ferrie~~ ferrous sprayhead 30b at the beginning of the flow path A. This initially coats the surface of the produce with liquid having ~~ferrie~~ ferrous ions. The produce is then exposed to the ozonised liquid from the next ozone sprayhead 30a. This ensures that free radical generation is strongest on the surface of the produce.

The produce travels on the upper conveyor belt 24 and moves along the rest of the flow path A through the dense free radical saturated atmosphere within the chamber 10. Depending on the produce and the length of time needed for sufficient decontamination, the speed of the conveyor belts 24 and 26 can be adjusted.

The produce drops through the vertical spacing between the upper and lower conveyor belts 24 and 26. This enables the entire exterior surface of the produce to be

fully exposed to the free radical atmosphere as it passes through the vertical spacing, and also the positioning of the produce to be altered from one conveyor belt 24 to the conveyor belt 26, thereby allowing other surfaces of the produce to be exposed to the free radical atmosphere for an extended period.

Again, depending on the produce, the distance of the vertical spacing between the upper and lower conveyor belts 24 and 26 will be pre-adjusted to prevent damage to the produce.

On reaching the end of the flow path A, the produce exits the chamber 10 through the produce outlet 14 (arrow F) and is collected by any suitable means.

By the generation and use of free radicals, a powerful oxidising agent and biocide can be utilised to decontaminate produce. This can be enhanced by the use of Fenton's Reaction and the incorporation of a second liquid having ~~ferrie~~ ferrous ions.

The volume of liquid necessary to produce the dense free radical saturated atmosphere within the chamber is nominal, and is preferably two to four litres per hour per sprayhead. By way of example, a chamber having twenty sprayheads therefore uses no more than eighty litres of water per hour. Such a chamber has a produce decontamination capacity of several hundred kilograms per hour.

It is thus possible to provide apparatus which can decontaminate or sterilise produce without the need for submersion in a chemically treated liquid. It is also

possible to provide apparatus which dramatically reduces the amount of liquid required for decontaminating produce.

The embodiment described above is given by way of example only, and modifications will be apparent to persons skilled in the art without departing from the scope of the invention as defined by the appended claims.

ABSTRACTPRODUCE DECONTAMINATION APPARATUS

~~Produce decontamination apparatus comprises~~ The invention provides a produce decontamination apparatus comprising a chamber 10 for accepting produce to be decontaminated and/or sterilised, and means for producing a free radical saturated atmosphere within the chamber 10 so that, in use, the free radical saturated atmosphere decontaminates and/or sterilises the produce. Preferably, the means for producing a free radical saturated atmosphere comprises one or more first atomising sprayheads 30a, a supply 32 of ozonised liquid which is supplied to the first sprayheads 30a, and means for breaking down the ozone forming part of the ozonised liquid once discharged from the first sprayheads 30a. Preferably, the means for breaking down the ozone is in the form of one or more UV light emitting devices 48,50. Produce decontaminated using the apparatus is also provided.

~~(Refer to the figure)~~